

State of Ohio
Department of Transportation

Structure Type Study

MED-18-12.99

Medina Township

Medina County

PID NO.: 88876

Table of Contents

Hydraulics and Hydrology Study..... 1

Bridge Alternatives..... 3

Appendix A – Structural Site Plan..... 5

Appendix B – Hydraulic Analysis Results..... 6

Appendix C – Detailed Cost Estimates..... 19

HYDROLOGY AND HYDRAULICS STUDY MED-18-1299 over West Branch Rocky River

Hydrology Narrative MED-18-1299 over West Branch Rocky River

Allowable Headwater Criteria:

Design Year Frequency = N/A (pedestrian structure)

Alternative I: Prefabricated Truss Bridge on Reinforced Concrete Abutments, 109' span

Alternative II: Steel Plate Girder Bridge on Reinforced Concrete Abutments, 109' span

Bridge Criteria:

- a. Maximum design headwater elevation should not exceed headwater elevation of 100 year storm for the existing structure – Elev. = 917.71

Therefore, the maximum allowable headwater elevation for the design year for alternatives I and II is 917.71.

Flood Hazard mapping was checked and it was determined that this location is in a FEMA flood hazard zone AE, as shown in Flood Insurance Rate Map (FIRM), Panel 164 of 450. The Flood Insurance Study (FIS) for Medina County, dated 8/19/2013, was obtained and utilized for the hydraulic analysis of this structure. Based on the FIS the West Branch Rocky River drains 21.1 square miles or 13504 acres to the structure site. The drainage area is considered rural based on typical land use. A Manning's n of 0.043 was used in the analysis. The peak flow discharge given at SR-18 was given in the FIS as 2358 cfs.

Due to the close proximity of the proposed pedestrian bridge to the existing SR-18 Bridge the analysis was completed for the SR-18 bridge system. The existing model includes the SR-18 structure and confirms the results are consistent with the FIS. The proposed model includes the SR-18 structure and the proposed pedestrian structure. The proposed pedestrian structure is offset 20' from the south side of the existing SR-18 structure. The pedestrian structure's rear abutment face matches the SR-18 structure's rear abutment face, and is located along the western edge of the 100-year floodplain. The pedestrian structure's forward abutment face was positioned further east than the SR-18 structure's forward abutment, so as to locate it in the ineffective flow area of the SR-18 structure. The SR-18 structure has a low-chord elevation of approximately 919.00. For that reason it was preferred to keep the pedestrian structure's low chord elevation at or above elevation 919.00.

The design flood frequency of 25 years does not apply because the structure is designed for pedestrian use and the low chord of the existing vehicular structure will be matched. The 100-year flood frequency was analyzed to confirm the proposed structure does not increase the headwater elevation upstream of the structure from the existing conditions.

A linear regression was performed based on the stream centerline profile. The calculated slopes, -0.0013608 for the upstream portion and 0.0020618 for the downstream portion, were used as estimated energy gradients. The approach section is approximately 104' from the upstream face of the proposed pedestrian structure, and the exit section is approximately 38' from the downstream face of the existing SR-18 structure.

Existing Structure MED-18-1299 over West Branch Rocky River

The existing SR-18 structure is a prestressed I-beam bridge with a span length of 93' and 20' long approach slabs at each end of the bridge. It is located on a horizontal tangent alignment with no skew. The out to out width of the structure is 76'. The bridge carries two lanes of traffic. The hydraulic

analysis results for the existing structure are summarized as follows based on the use of the HEC-RAS program.

STORM	Q	VELOCITY	HEADWATER	HEAD EL.
100-year	2358 cfs	6.39 fps	12.29 ft	917.71

Proposed Alternative I MED-18-1299 over West Branch Rocky River

Alternative I is a prefabricated truss bridge on reinforced concrete abutments with a 109’ span. The proposed structure has no skew. The out to out width of the structure is 12’ with drainage over the sides. The hydraulic analysis results for the proposed structure are summarized as follows based on the use of the HEC-RAS program.

STORM	Q	VELOCITY	HEADWATER	HEAD EL.
100-year	2358 cfs	6.39 fps	12.29 ft	917.71

Proposed Alternative II MED-18-1299 over West Branch Rocky River

Alternative II is a steel plate girder bridge on reinforced concrete abutments with a 109’ span. The proposed structure has no skew. The out to out width of the structure is 12’ with drainage over the sides. The hydraulic analysis results for the proposed structure are summarized as follows based on the use of the HEC-RAS program.

STORM	Q	VELOCITY	HEADWATER	HEAD EL.
100-year	2358 cfs	6.39 fps	12.29 ft	917.71

Hydraulic Results MED-18-1299 over West Branch Rocky River

The hydraulic analysis results confirm that the proposed pedestrian structure will not impact the hydraulic performance of the existing SR-18 structure. This result was expected based on positioning of the pedestrian bridge abutments outside the effective flow area of the SR-18 structure, and placing the superstructure above the existing 100-year flood elevation.

Scour Analysis MED-18-1299 over West Branch Rocky River

Soil borings indicate that bedrock is excessively deep and friction piles will need to be used. Scour analysis was performed per HEC-18. The D₅₀ was unknown so a conservative value of 0.2 mm was used per HEC-18 page 6.2. The abutment scour depth was determined to be 1.59’ and the contraction scour depth was determined to be 2.29’, giving a total scour depth of 3.88’.

BRIDGE ALTERNATIVES- MED-18-1299

Alternative I

Alternative I is a prefabricated truss bridge on reinforced concrete abutments with a 109' span. The proposed structure has no skew. The proposed span and rise dimensions provide adequate hydraulic capacity for the structure.

The advantages associated with this alternative are:

- It is more aesthetically pleasing than Alternative II.
- The prefabricated truss will have a slightly faster construction time due to pre-assembly at the plant, and inclusion of the deck pans.
- Weathering steel can be utilized to eliminate the need for initial painting.

The disadvantages associated with this alternative are:

- It has a slightly higher estimated construction cost than Alternative II.

Alternative II

Alternative II is a steel plate girder bridge on reinforced concrete abutments with a 109' span. The proposed structure has no skew. The proposed span and rise dimensions provide adequate hydraulic capacity for the structure.

The advantages associated with this alternative are:

- It has a slightly lower estimated construction cost.
- Weathering steel can be utilized to eliminate the need for initial painting.

The disadvantages associated with this alternative are:

- Deeper superstructure places low chord closer to the water and potential debris impact.

Alternative III

Alternative III is a prestressed concrete I-beam bridge on reinforced concrete abutments with a 109' span. The only prestressed concrete I-beam section adequate for the given span and loadings would be a WF 72-49. This section is too deep and would go below the proposed minimum low chord elevation of 919.00; as such, Alternative III was eliminated from further consideration.

Cost Estimate Summary

Complete construction cost estimates (inflated 3% per year for the construction season) were prepared for all the alternatives and can be found in appendix C.

	ALTERNATIVE I	ALTERNATIVE II
STRUCTURE	\$303,700	\$284,300
GRAND TOTAL INCLUDES INFLATION + CONTINGENCY	\$364,400	\$341,200

Foundation Recommendation Summary

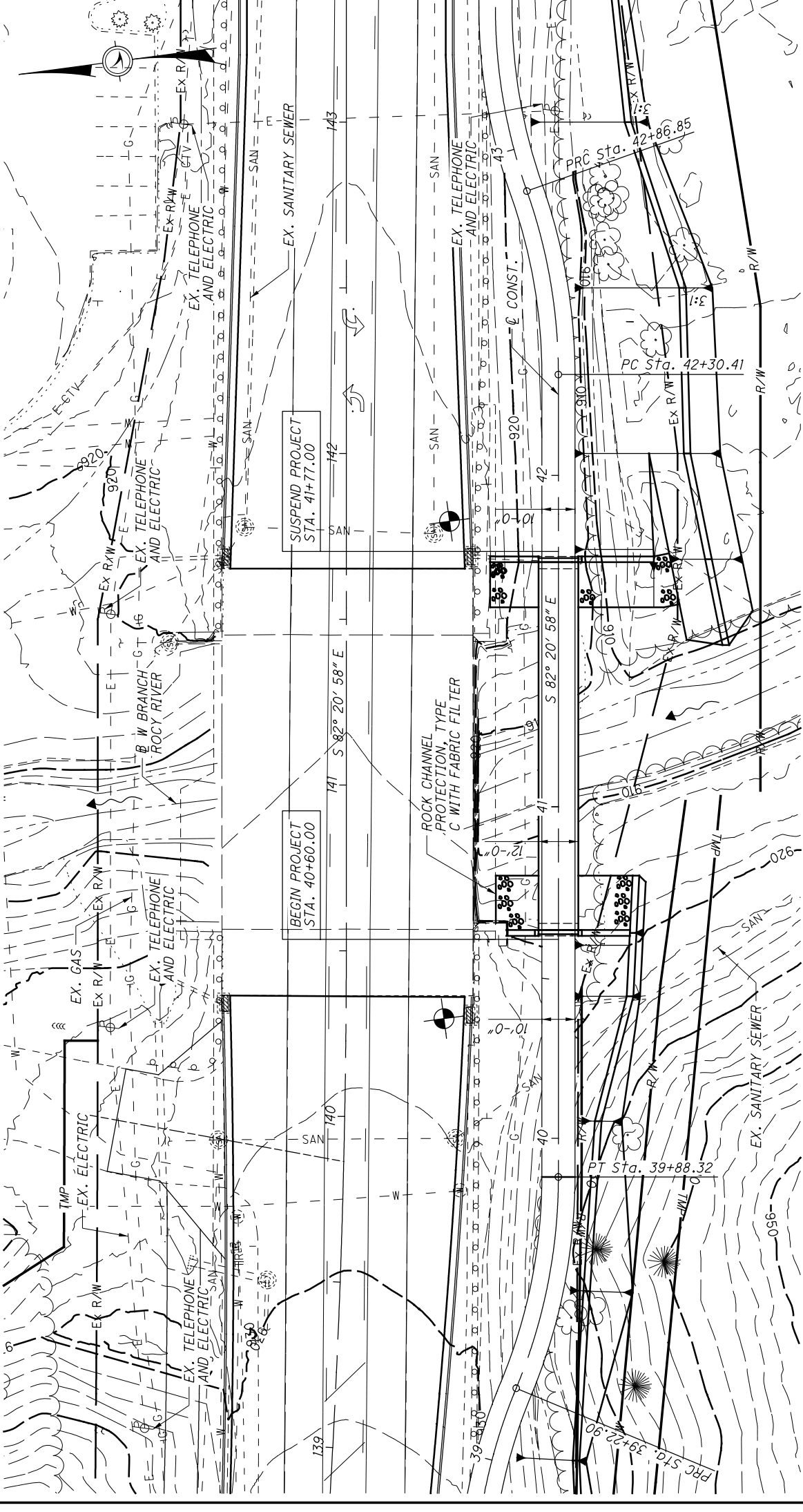
Bedrock was found to be excessively deep, so foundations will rely on 12-inch diameter CIP friction piles. Contributions of soil above the calculated scour depths will be disregarded in the pile capacity.

Recommendation

Alternative I, the prefabricated truss bridge on reinforced concrete abutments, is being recommended as the preferred alternative. Since cost difference is minimal (7%), this decision can be based on secondary considerations such as aesthetics. Prefabricated trusses are commonly used as bridges on non-motorized

paths. The public has come to expect and desire this type of bridge when circumstances allow for their use.

Appendix A
Structural Site Plan



BENCHMARK DATA

BM #1 STA. 141+44.60 ELEV. 924.893 OFFSET 40.30', LT

FOR ADDITIONAL BENCHMARK INFORMATION. SEE ROADWAY PLAN SHEET

NOTES

ALL SLOPES ARE 2:1 UNLESS OTHERWISE SHOWN. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

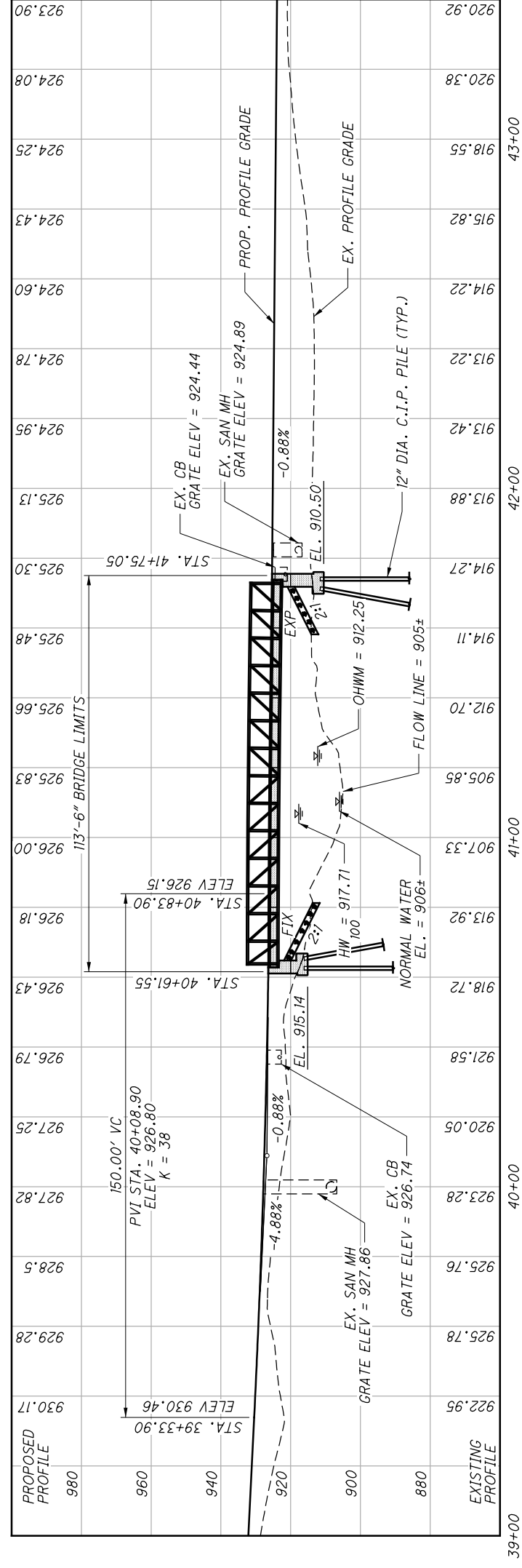
LEGEND

BORING LOCATION

HYDRAULIC DATA

DRAINAGE AREA = 21.1 SQ. MILES
 Q (100) = 2358 CFS (FIS) V (100) = 6.39 FT/S
 STRUCTURE CLEARS THE 100 YEAR DESIGN HW BY 1.29 FEET.

PLAN

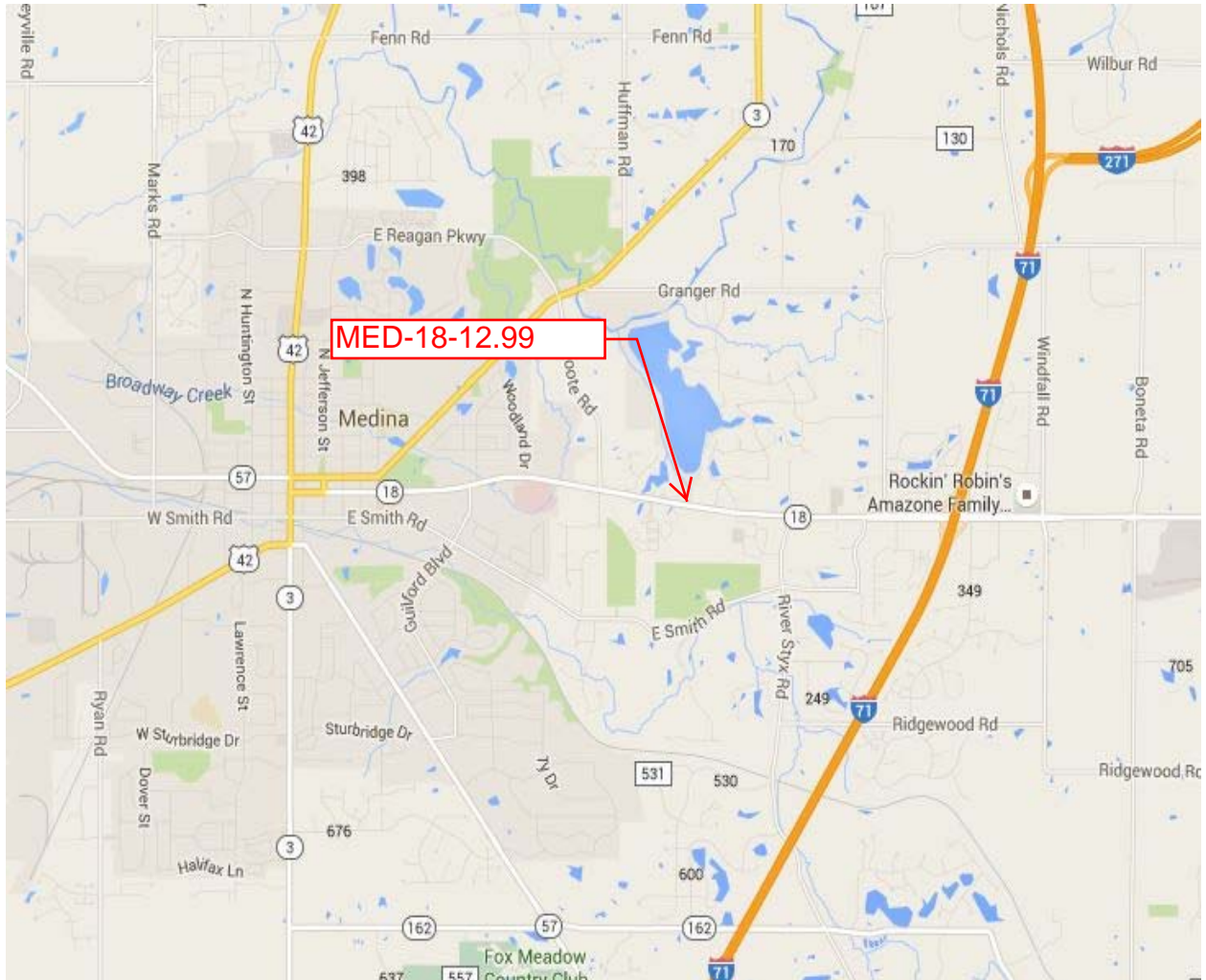


PROFILE ALONG C CONSTRUCTION

PROPOSED STRUCTURE

TYPE: SINGLE SPAN PREFABRICATED PEDESTRIAN TRUSS BRIDGE WITH REINFORCED CONCRETE ABUTMENTS ON FRICTION PILES
 SPAN: 109'-0" C/BRG. TO C/BRG.
 ROADWAY: 12'-0" F/F RAILING
 LOADING: 90 PSF PEDESTRIAN LOAD OR H15 TRUCK
 SKEW: 0°00'00"
 APPROACH SLABS: NONE
 ALIGNMENT: TANGENT
 CROWN: 0.016
 COORDINATES: LATITUDE 41.136956 LONGITUDE -81.822274

Appendix B
Hydraulic Analysis Results



REGRESSION ANALYSIS OF EXISTING UPSTREAM PROFILE - MED-18-1299 OVER WEST BRANCH ROCKY RIVER

Upstream
Channel Profile

River Sta.	Dist.	Elev.
50+68.14	0	906.1
50+98.3	30.16	905.29
51+20.13	51.99	905.45
51+51.94	83.8	905.29
51+76.4	108.26	905.47
52+00	131.86	905.57
52+32.29	164.15	904.96

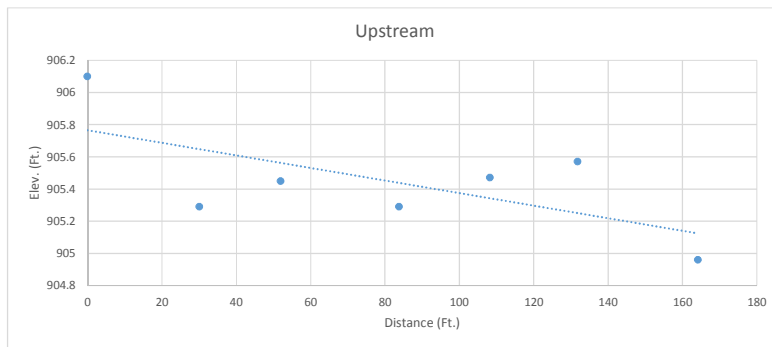
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.316301727
R Square	0.100046782
Adjusted R Square	-0.124941522
Standard Error	0.228114105
Observations	6

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.023139153	0.023139153	0.44467548	0.541369895
Residual	4	0.20814418	0.052036045		
Total	5	0.231283333			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	905.4676588	0.215138472	4208.766812	1.91219E-14	904.8703387	906.064979	904.8703387	906.064979
0	-0.001360796	0.002040663	-0.666839921	0.541369895	-0.007026586	0.004304994	-0.007026586	0.004304994



REGRESSION ANALYSIS OF EXISTING DOWNSTREAM PROFILE - MED-18-1299 OVER WEST BRANCH ROCKY RIVER

Downstream
Channel Profile

River Sta.	Dist.	Elev.
53+43	0	905.62
53+72.66	29.66	905.14
54+00	57	903.36
54+41.59	98.59	902.46
54+75	132	902.83
55+00	157	903.32
55+35	192	904.27
55+88.45	245.45	904.81

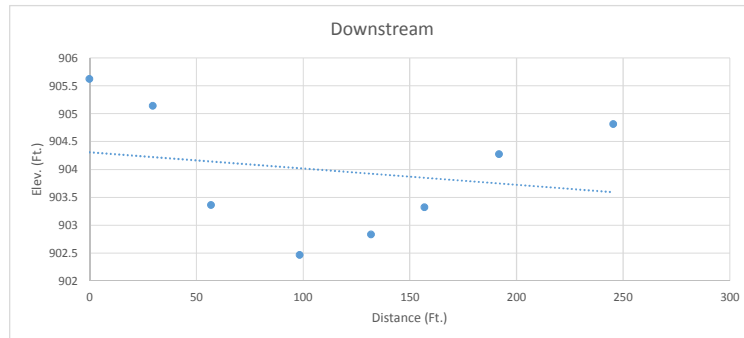
SUMMARY OUTPUT

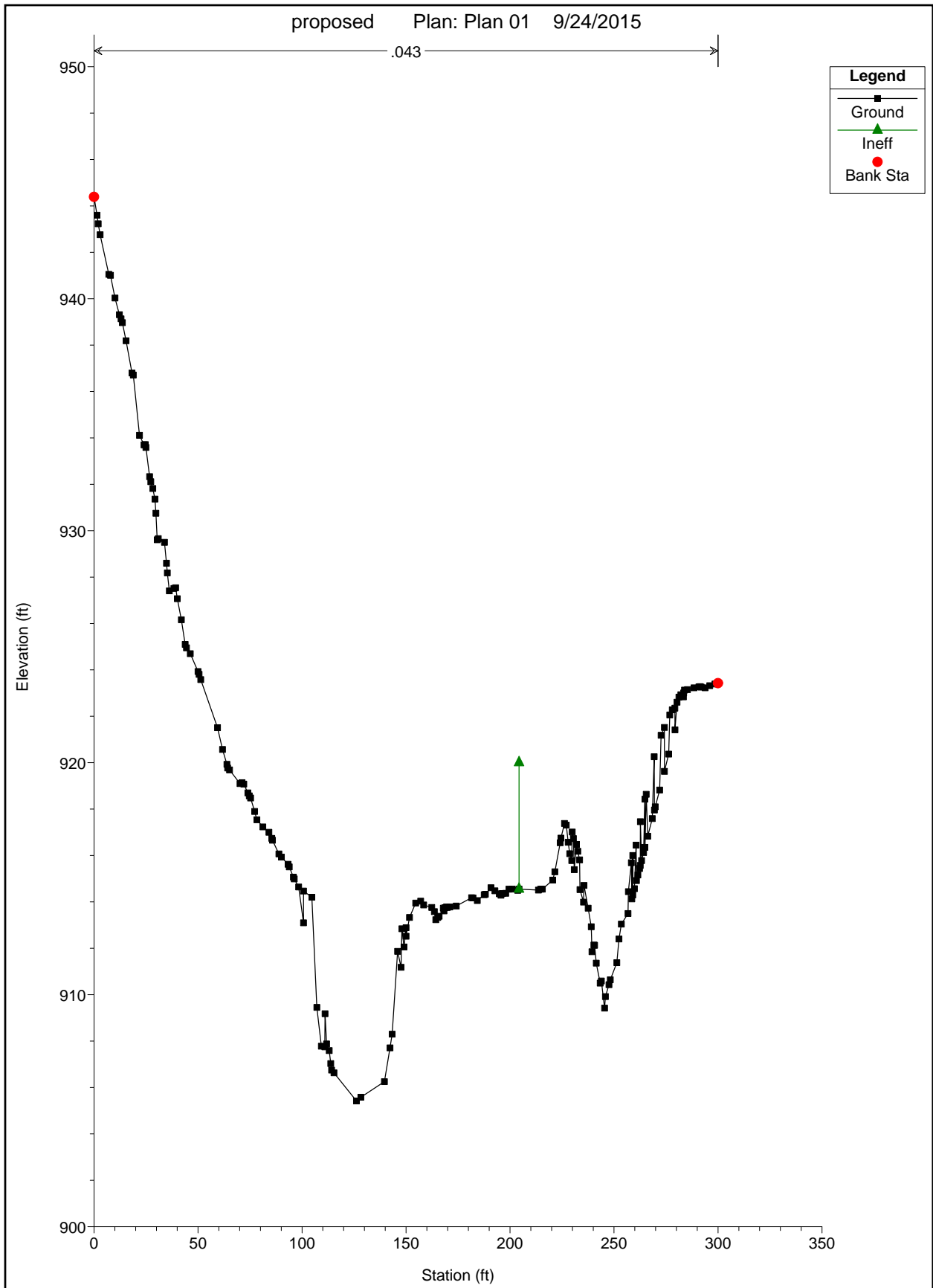
Regression Statistics	
Multiple R	0.153666011
R Square	0.023613243
Adjusted R Square	-0.171664109
Standard Error	1.097936168
Observations	7

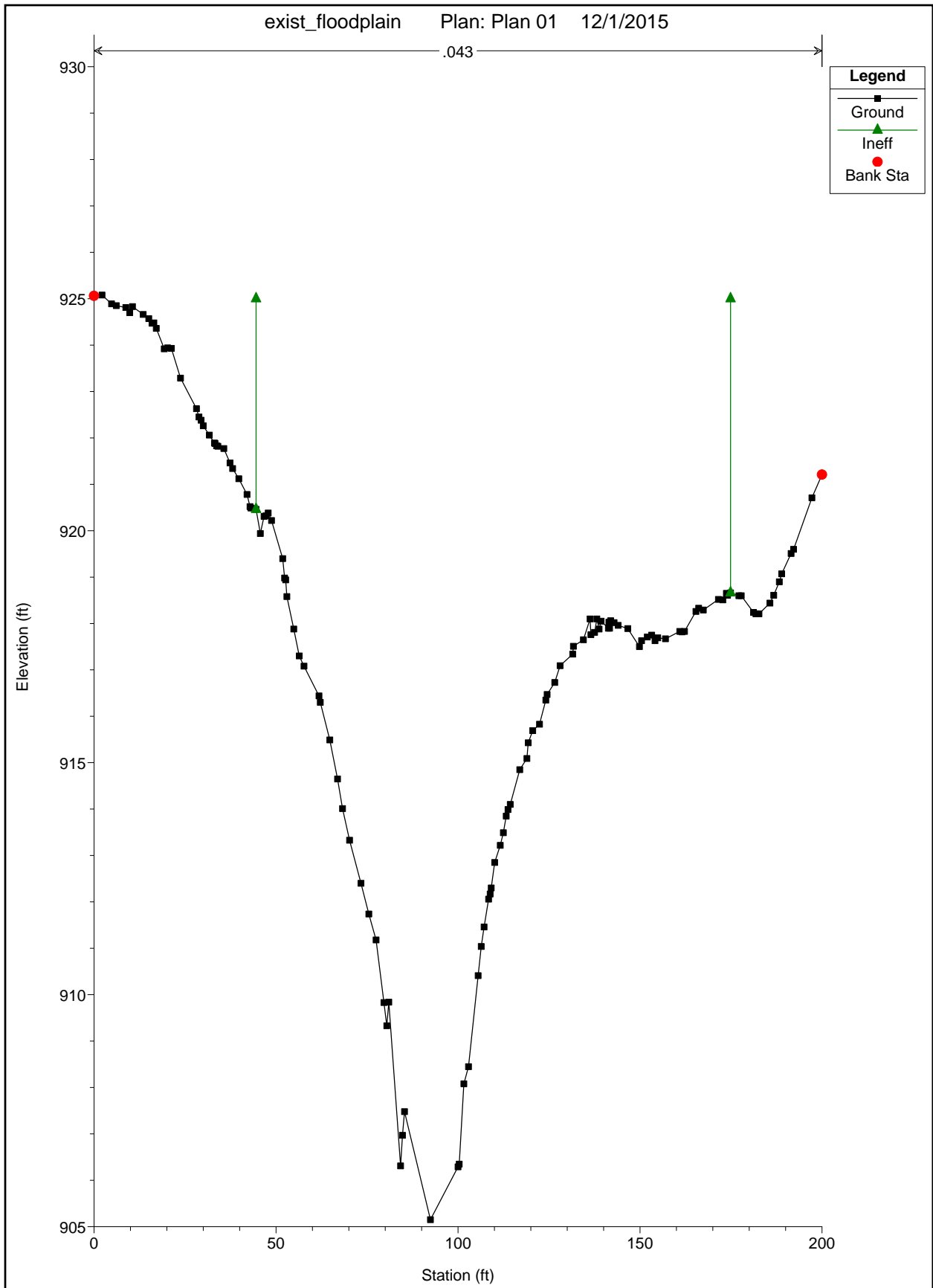
ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.145766572	0.145766572	0.120921565	0.742197549
Residual	5	6.027319142	1.205463828		
Total	6	6.173085714			

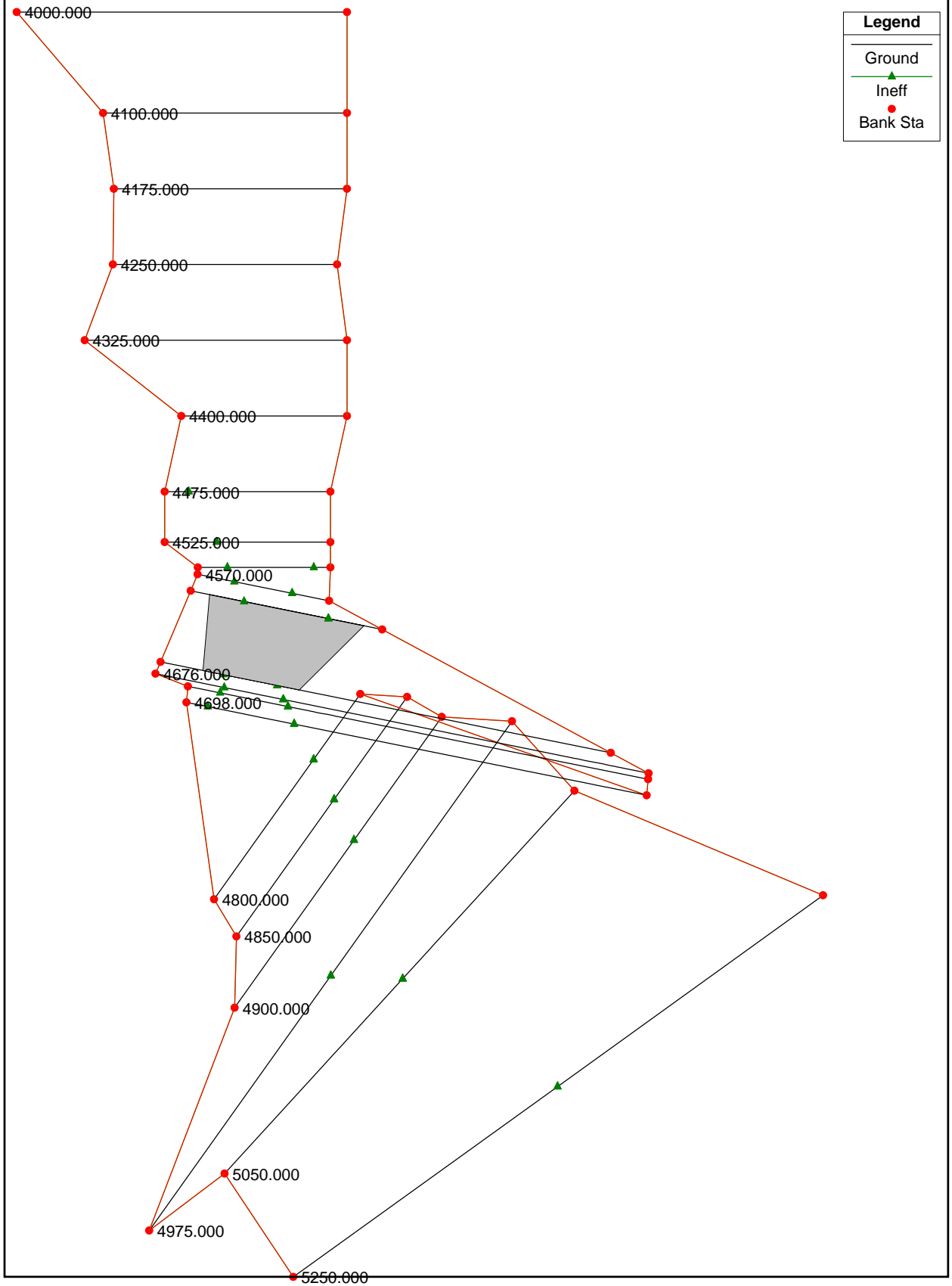
	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	903.4728907	0.876679777	1030.56203	1.63278E-14	901.2193136	905.7264678	901.2193136	905.7264678
0	0.002061824	0.005929249	0.347737781	0.742197549	-0.013179797	0.017303445	-0.013179797	0.017303445

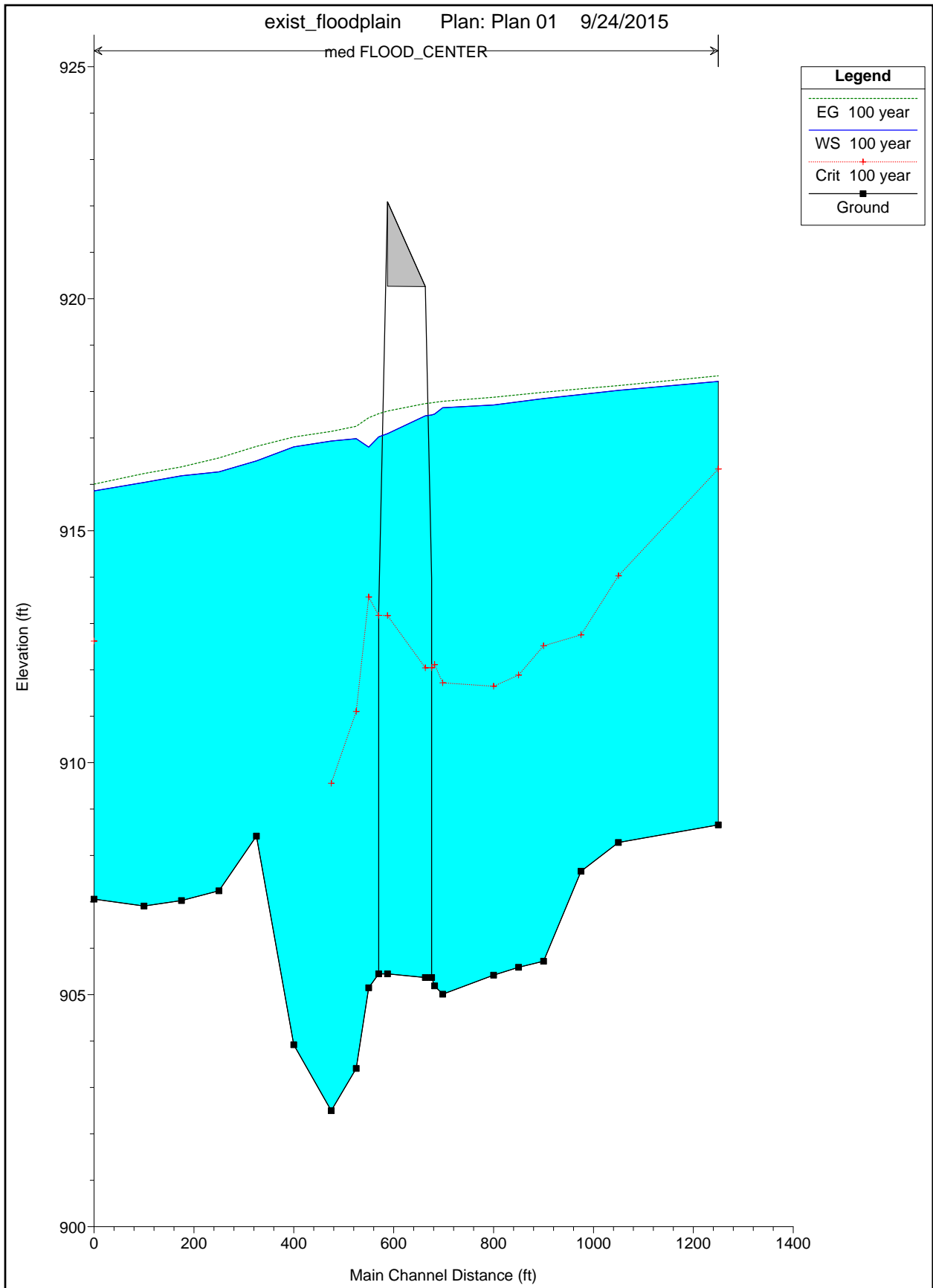


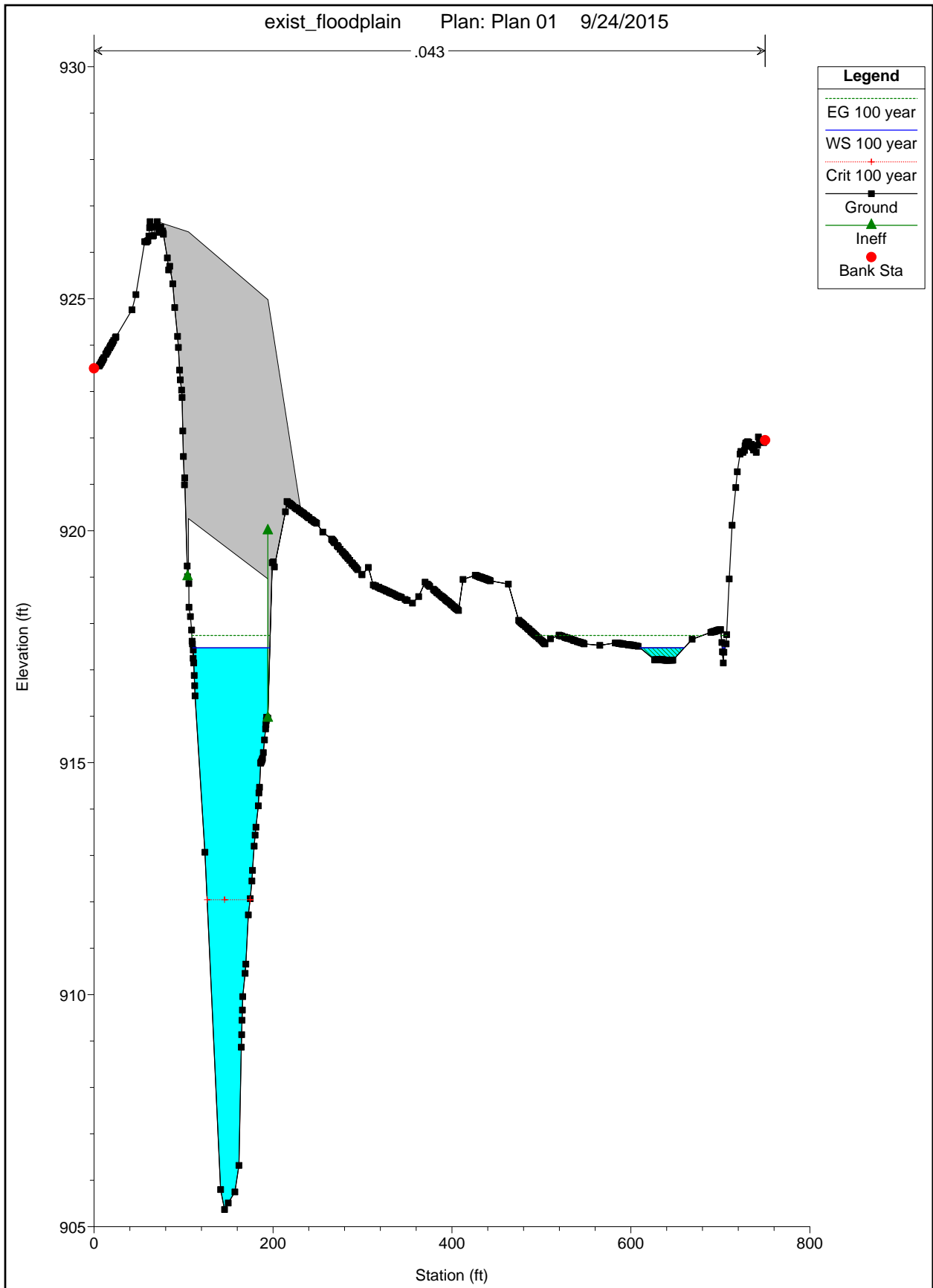




Legend	
Ground	▲
Ineff	▲
Bank Sta	●







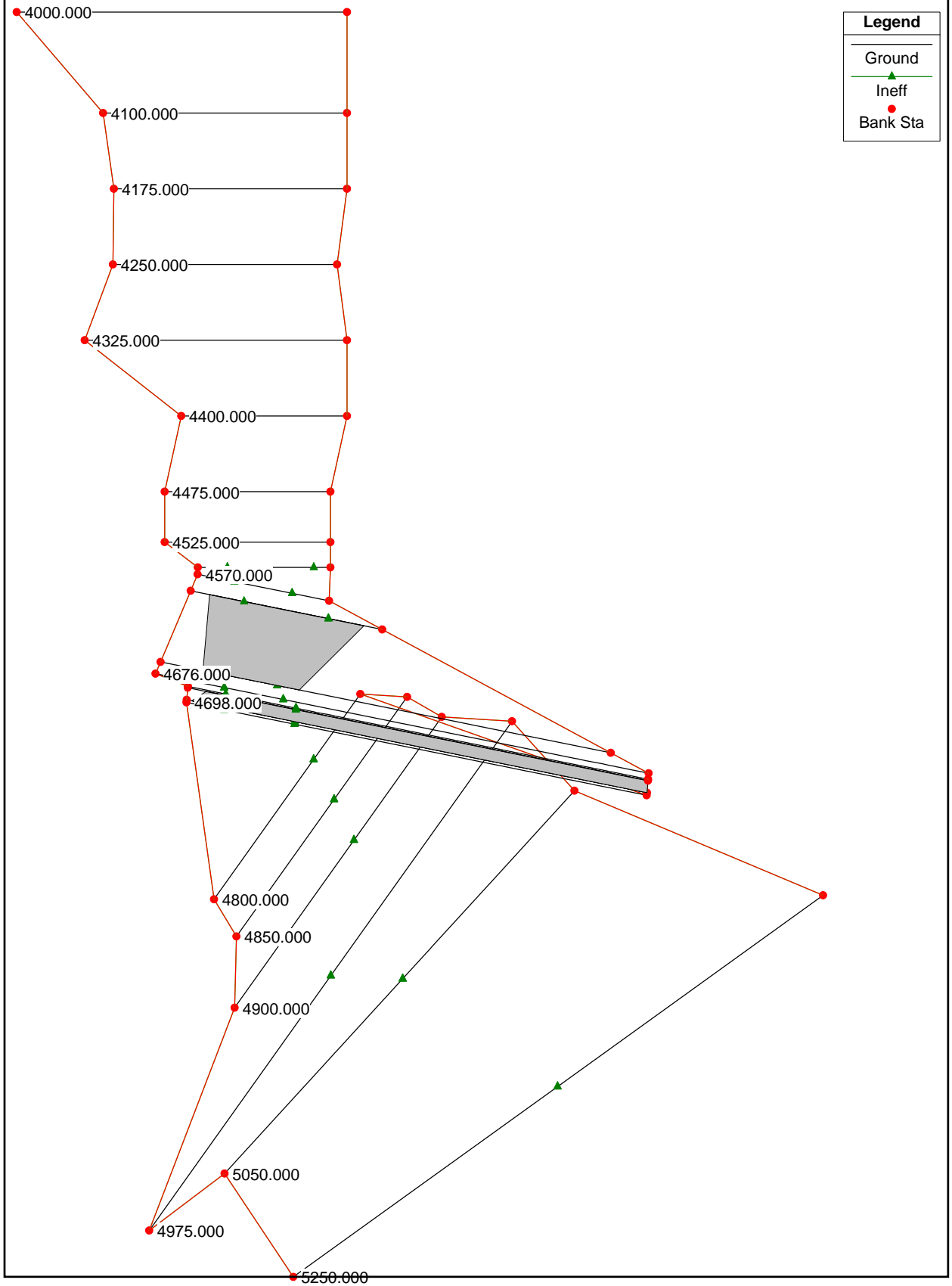
Plan: Plan 01 med FLOOD_CENTER RS: 4800.000 Profile: 100 year

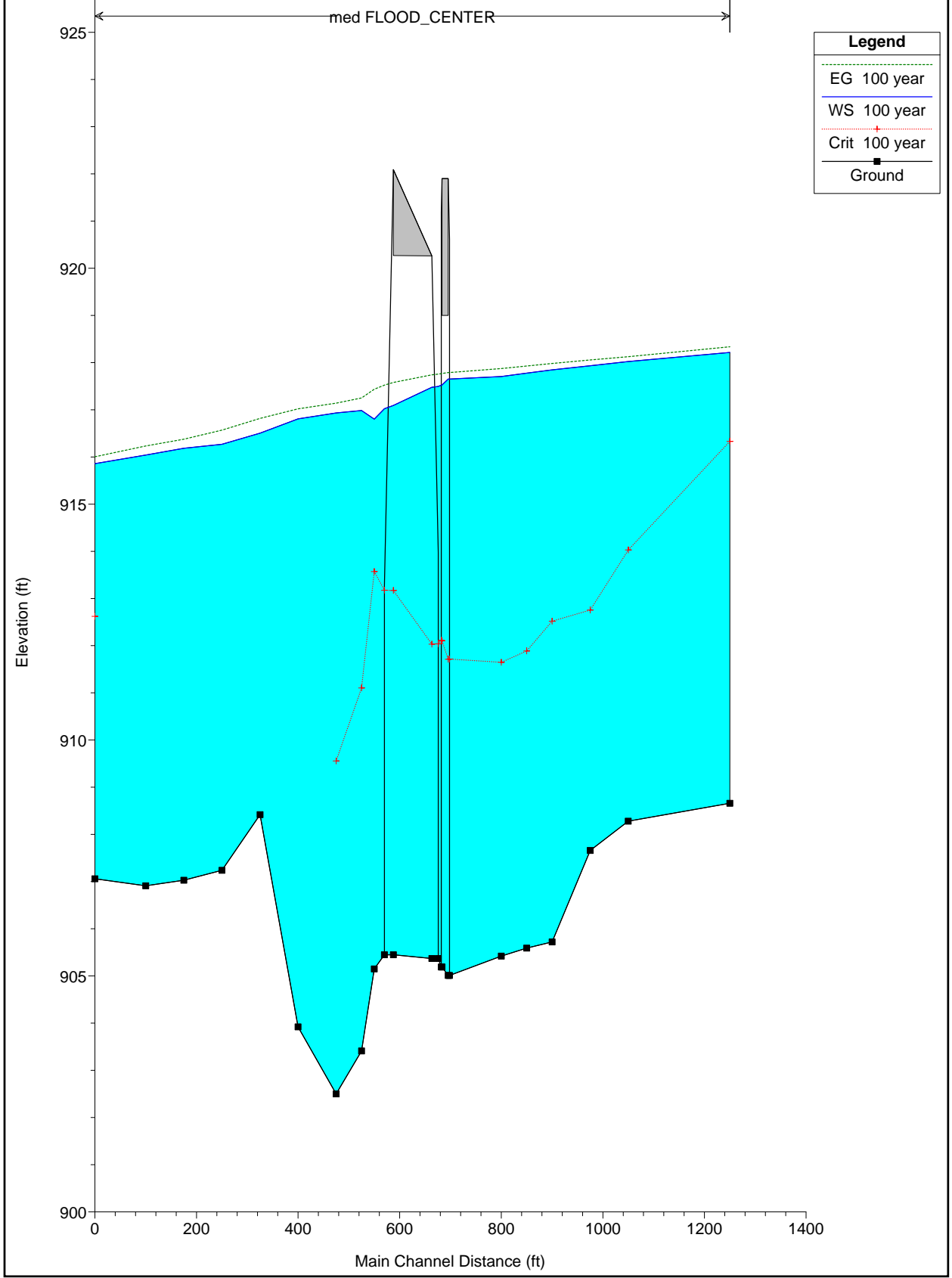
E.G. Elev (ft)	917.88	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.		0.043	
W.S. Elev (ft)	917.71	Reach Len. (ft)	102.00	102.00	102.00
Crit W.S. (ft)	911.65	Flow Area (sq ft)		716.05	
E.G. Slope (ft/ft)	0.001029	Area (sq ft)		935.25	
Q Total (cfs)	2358.00	Flow (cfs)		2358.00	
Top Width (ft)	189.79	Top Width (ft)		189.79	
Vel Total (ft/s)	3.29	Avg. Vel. (ft/s)		3.29	
Max Chl Dpth (ft)	12.29	Hydr. Depth (ft)		5.66	
Conv. Total (cfs)	73523.6	Conv. (cfs)		73523.6	
Length Wtd. (ft)	102.00	Wetted Per. (ft)		139.80	
Min Ch El (ft)	905.42	Shear (lb/sq ft)		0.33	
Alpha	1.00	Stream Power (lb/ft s)	300.01	0.00	0.00
Frctn Loss (ft)	0.08	Cum Volume (acre-ft)		14.74	
C & E Loss (ft)	0.01	Cum SA (acres)		3.58	

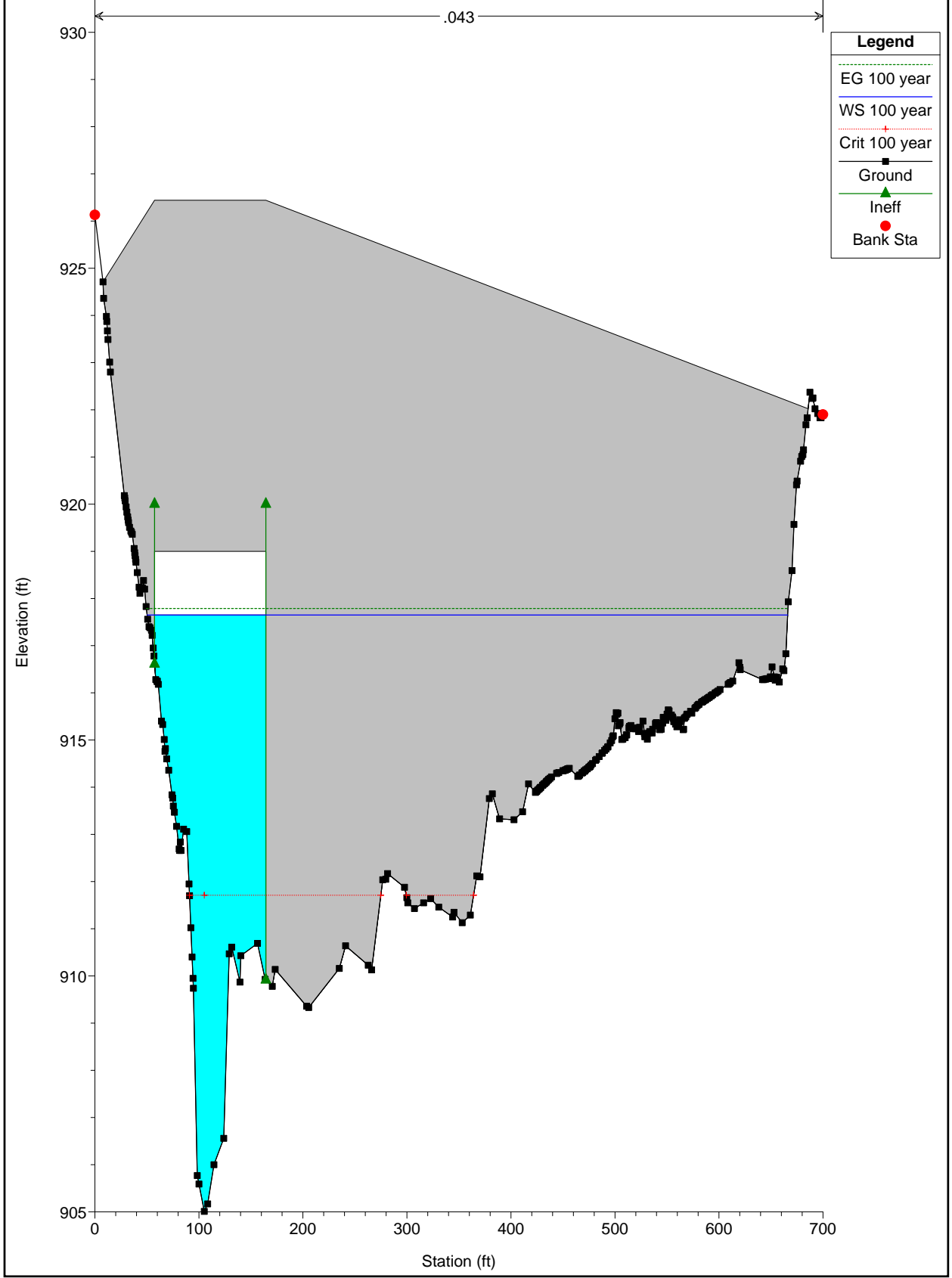
Plan: Plan 01 med FLOOD_CENTER RS: 4525.000 Profile: 100 year

E.G. Elev (ft)	917.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.27	Wt. n-Val.		0.043	
W.S. Elev (ft)	916.98	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	911.10	Flow Area (sq ft)		569.54	
E.G. Slope (ft/ft)	0.002361	Area (sq ft)		569.54	
Q Total (cfs)	2358.00	Flow (cfs)		2358.00	
Top Width (ft)	120.91	Top Width (ft)		120.91	
Vel Total (ft/s)	4.14	Avg. Vel. (ft/s)		4.14	
Max Chl Dpth (ft)	13.57	Hydr. Depth (ft)		4.71	
Conv. Total (cfs)	48530.2	Conv. (cfs)		48530.2	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		147.09	
Min Ch El (ft)	903.41	Shear (lb/sq ft)		0.57	
Alpha	1.00	Stream Power (lb/ft s)	250.00	0.00	0.00
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)		7.60	
C & E Loss (ft)	0.02	Cum SA (acres)		2.08	

Legend	
Ground	▲
Ineff	▲
Bank Sta	●







Plan: Plan 01 med FLOOD_CENTER RS: 4800.000 Profile: 100 year

E.G. Elev (ft)	917.87	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.		0.043	
W.S. Elev (ft)	917.71	Reach Len. (ft)	102.00	102.00	102.00
Crit W.S. (ft)	911.65	Flow Area (sq ft)		715.61	
E.G. Slope (ft/ft)	0.001031	Area (sq ft)		934.60	
Q Total (cfs)	2358.00	Flow (cfs)		2358.00	
Top Width (ft)	189.78	Top Width (ft)		189.78	
Vel Total (ft/s)	3.30	Avg. Vel. (ft/s)		3.30	
Max Chl Dpth (ft)	12.29	Hydr. Depth (ft)		5.66	
Conv. Total (cfs)	73453.5	Conv. (cfs)		73453.5	
Length Wtd. (ft)	102.00	Wetted Per. (ft)		139.79	
Min Ch El (ft)	905.42	Shear (lb/sq ft)		0.33	
Alpha	1.00	Stream Power (lb/ft s)	300.01	0.00	0.00
Frctn Loss (ft)	0.08	Cum Volume (acre-ft)		14.30	
C & E Loss (ft)	0.01	Cum SA (acres)		3.43	

Plan: Plan 01 med FLOOD_CENTER RS: 4525.000 Profile: 100 year

E.G. Elev (ft)	917.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.27	Wt. n-Val.		0.043	
W.S. Elev (ft)	916.98	Reach Len. (ft)	50.00	50.00	50.00
Crit W.S. (ft)	911.10	Flow Area (sq ft)		569.54	
E.G. Slope (ft/ft)	0.002361	Area (sq ft)		569.54	
Q Total (cfs)	2358.00	Flow (cfs)		2358.00	
Top Width (ft)	120.91	Top Width (ft)		120.91	
Vel Total (ft/s)	4.14	Avg. Vel. (ft/s)		4.14	
Max Chl Dpth (ft)	13.57	Hydr. Depth (ft)		4.71	
Conv. Total (cfs)	48530.2	Conv. (cfs)		48530.2	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		147.09	
Min Ch El (ft)	903.41	Shear (lb/sq ft)		0.57	
Alpha	1.00	Stream Power (lb/ft s)	250.00	0.00	0.00
Frctn Loss (ft)	0.09	Cum Volume (acre-ft)		7.60	
C & E Loss (ft)	0.02	Cum SA (acres)		2.08	

Appendix C
Detailed Cost Estimates

Estimate MED-18-1299

Estimated Cost:\$303,658.19

Contingency: 20.00%

Estimated Total: \$364,389.83

Base Date: 12/01/15

Spec Year: 13

Unit System: E

Work Type: BRIDGE REPLACEMENT

Highway Type: THIS CODE TABLE CURRENTLY NOT USED

Urban/Rural Type: RURAL CLASS

Season: SUMMER

County: MEDINA

Latitude of Midpoint: 410808

Longitude of Midpoint: -814949

District: 03

Federal/State Project Number:

Estimate Type: Preliminary - Prefabricated Truss Bridge

Prepared by MDA on 12/01/15

Checked by JBD on 12/01/15

Approved by JBD on 12/01/15

<u>Line #</u>	<u>Item Number</u>	<u>Quantity</u>	<u>Units</u>	<u>Unit Price</u>	<u>Extension</u>
<u>Description</u>					
<u>Supplemental Description</u>					

Group 1200: STRUCTURE

0005	503E11100	1.000	LS	\$5,000.00000	\$5,000.00
COFFERDAMS AND EXCAVATION BRACING					
0006	503E21100	83.000	CY	\$53.26952	\$4,421.37
0007	505E11100	1.000	LS	\$10,000.00000	\$10,000.00
PILE DRIVING EQUIPMENT MOBILIZATION					
0008	507E00500	2,100.000	FT	\$8.91059	\$18,712.24
12" CAST-IN-PLACE REINFORCED CONCRETE PILES, DRIVEN					
0009	507E00550	2,100.000	FT	\$31.87039	\$66,927.82
12" CAST-IN-PLACE REINFORCED CONCRETE PILES, FURNISHED					
0010	509E10000	10,350.000	LB	\$1.34981	\$13,970.53
EPOXY COATED REINFORCING STEEL					
0011	511E32210	25.000	CY	\$826.32672	\$20,658.17
CLASS QC2 CONCRETE, SUPERSTRUCTURE					
0012	511E43510	122.000	CY	\$427.13868	\$52,110.92
CLASS QC1 CONCRETE, ABUTMENT INCLUDING FOOTING					
0013	518E21200	59.000	CY	\$67.87532	\$4,004.64
POROUS BACKFILL WITH FILTER FABRIC					
0014	523E20000	2.000	EACH	\$2,968.67089	\$5,937.34
DYNAMIC LOAD TESTING					
0015	523E20500	2.000	EACH	\$1,957.57895	\$3,915.16
RESTRIKE					
0016	690E98400	1.000	LS	\$98,000.00000	\$98,000.00
SPECIAL - MISC.:					
<i>Prefabricated Truss Bridge</i>					

Total for Group 1200:\$303,658.19

Estimate MED-18-1299

Estimated Cost:\$284,342.33

Contingency: 20.00%

Estimated Total: \$341,210.80

Base Date: 12/01/15

Spec Year: 13

Unit System: E

Work Type: BRIDGE REPLACEMENT

Highway Type: THIS CODE TABLE CURRENTLY NOT USED

Urban/Rural Type: RURAL CLASS

Season: SUMMER

County: MEDINA

Latitude of Midpoint: 410808

Longitude of Midpoint: -814949

District: 03

Federal/State Project Number:

Estimate Type: Preliminary - Plate Girder Bridge

Prepared by MDA on 12/01/15

Checked by JBD on 12/01/15

Approved by JBD on 12/01/15

<u>Line #</u>	<u>Item Number</u>	<u>Quantity</u>	<u>Units</u>	<u>Unit Price</u>	<u>Extension</u>
<u>Description</u>					
<u>Supplemental Description</u>					
Group 1200: STRUCTURE					
0005	503E11100	1.000	LS	\$5,000.00000	\$5,000.00
COFFERDAMS AND EXCAVATION BRACING					
0006	503E21100	83.000	CY	\$53.26952	\$4,421.37
0007	505E11100	1.000	LS	\$10,000.00000	\$10,000.00
PILE DRIVING EQUIPMENT MOBILIZATION					
0008	507E00500	2,100.000	FT	\$8.91059	\$18,712.24
12" CAST-IN-PLACE REINFORCED CONCRETE PILES, DRIVEN					
0009	507E00550	2,100.000	FT	\$31.87039	\$66,927.82
12" CAST-IN-PLACE REINFORCED CONCRETE PILES, FURNISHED					
0010	509E10000	12,050.000	LB	\$1.33334	\$16,066.75
EPOXY COATED REINFORCING STEEL					
0011	511E32210	35.000	CY	\$826.32672	\$28,921.44
CLASS QC2 CONCRETE, SUPERSTRUCTURE					
0012	511E43510	122.000	CY	\$427.13868	\$52,110.92
CLASS QC1 CONCRETE, ABUTMENT INCLUDING FOOTING					
0013	513E10280	19,311.000	LB	\$1.72144	\$33,242.73
STRUCTURAL STEEL MEMBERS, LEVEL 4					
0014	513E20000	660.000	EACH	\$4.49288	\$2,965.30
WELDED STUD SHEAR CONNECTORS					
0015	516E44300	4.000	EACH	\$1,090.77974	\$4,363.12
ELASTOMERIC BEARING WITH INTERNAL LAMINATES AND LOAD PLATE (NEOPRENE)					
0016	517E75120	220.000	FT	\$126.15226	\$27,753.50
RAILING (CONCRETE PARAPET WITH DOUBLE PIPE RAIL)					
0017	518E21200	59.000	CY	\$67.87532	\$4,004.64
POROUS BACKFILL WITH FILTER FABRIC					
0018	523E20000	2.000	EACH	\$2,968.67089	\$5,937.34
DYNAMIC LOAD TESTING					
0019	523E20500	2.000	EACH	\$1,957.57895	\$3,915.16
RESTRIKE					

Total for Group 1200:\$284,342.33